



# **3<sup>RD</sup> SPACE EXPLORATION CONFERENCE & EXHIBIT**

## **Lunar Biomedical Research**

**Presenter: Neal. R. Pellis, Ph.D.**

**Title: Senior Scientist, Space Life Sciences Directorate  
NASA Johnson Space Center  
Houston, TX 77058**

**Date: February 27, 2008**

# Outline



- Rationale for Lunar research
- Proposed research
- Recommendations from the NASA Advisory Council (NAC)
- Preliminary responses from NASA



# Rationale



- **The Moon offers the opportunity to resolve numerous issues associated with establishing relative autonomous human capability beyond LEO**
  - **Close proximity to Earth resources during the ‘learning’ phase**
  - **First opportunity to observe the adaptation of humans to lower gravity (1/6G) environments for extended durations (6 months)**
  - **Logical setting for staging our understanding of the human response to habitation and exploration in an extreme environment**
  - **Preparation for expeditions to Mars**



# Goals



- Accumulate a medical and research database on short and long duration lunar missions
- Validate findings from analog experiments
- Validate medical and scientific equipment
- Validate countermeasures
- Optimize crew health and performance

# Proposed Research



- Basis of the Research Program
  - Support human health and effectiveness during a mission (a medical operations function)
  - Perform investigations to better understand health risks
  - Investigate how to mitigate them for future missions
  - Ensure that human capabilities and limitations (human factors) are considered during the design and operation of the program
  - Investigate the environmental health risks in long duration lunar habitation

# Principal Areas of Research



- Space Radiation
  - Monitoring
  - Protection
- Medical Care- range of medical care scaled to risks, duration of return, *in loco* capabilities
- Countermeasures
  - Equipment
  - Pharmacological
  - Preventative
  - Training
- Physiology
  - Bone loss
  - Muscle deconditioning
  - Nutrition and food storage
  - Cardiovascular dynamics and performance
  - Neurovestibular adaptations
  - Immune function and wound healing

# Principal Areas of Research



- Behavioral Health and Performance
  - Small group dynamics
  - Performance metrics (cognitive)
  - Sleep
- Human Factors and Environmental Health
  - Dust
  - Microbial flora and toxicology
  - EVA suits and support
  - Habitat

# Recommendations from the NASA Advisory Council (NAC)



- Lunar Biomedical Research Workshop (June 27-29, 2007)
- More than 50 invitees
- Attendance by over 30 participants
- Participants from
  - Extramural science and medical community
  - NAC
  - NSBRI
  - NIH
  - NASA
- The Workshop provided 12 recommendations to NASA through the NAC



# Recommendations from the NASA Advisory Council (NAC)



Data from astronauts in  $1/6 g$

- » Maximize the number (1)
- » Perform serial measurements (2)
- » Analyze archived data & specimens (2)

Dedicated laboratory on the moon

- » Both human and animal (4)
- » Designate it a "national lab"

Perform experiments in non-human models

- » Use the model to understand 30-month exposure to micro and fractional gravity (5)

Intensive behavioral health program (2-3 yr mission)

- » Prolonged stays (6)
- » Historical data from exploration (Earth) and military expeditions (6)

# Recommendations from the NASA Advisory Council (NAC)



## Crew

- » Train crew as contributing colleagues for experiments (7)
- » Train as primary and secondary health providers (9)

## Human Factors

- » Vehicle and Habitat design – use historic performance data (5)

## Preventive medicine

- » Identify health hazards (10)
- » Maximize qualified pool of crew (10)
- » Enhanced personalized medicine (11)

## New space craft

- » Simulation capabilities integrated into space craft (12)
- » Ascent, descent, landing to & from moon and Mars, as well as Earth return

# Implications



- **For transit-** microgravity, radiation, habitation and logistics are target areas for investigation
- **For lunar and planetary habitation and exploration-** fractional G, radiation, habitation, logistics, and environment are the target areas for investigation
- The Moon is the first opportunity to accumulate data necessary to understand the relationship of gravity to biological function

# Preliminary Response



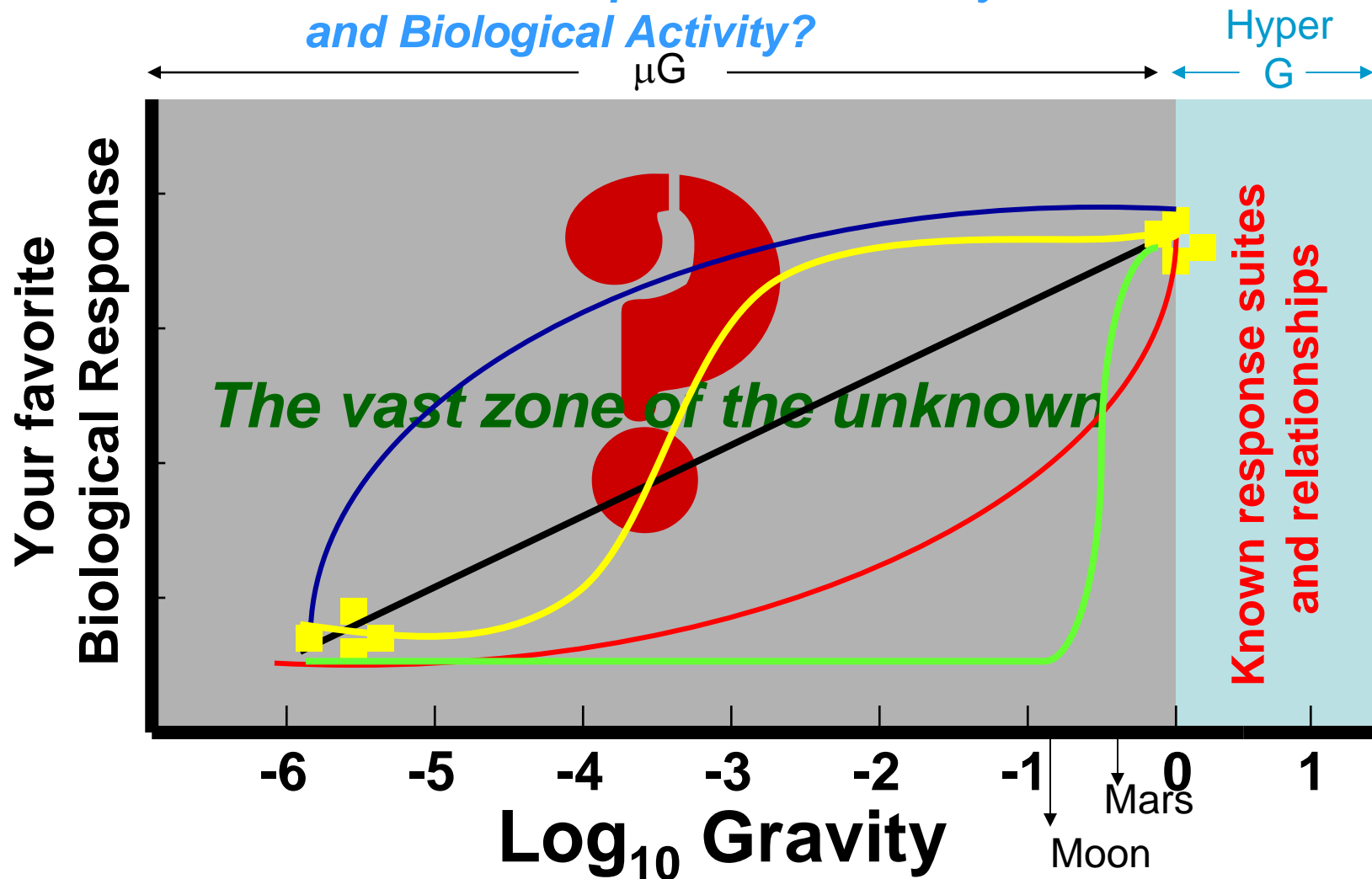
- The response to the recommendations from NASA is not yet completed and is anticipated later in the spring
- All 12 recommendations already have some level of concurrence
- Some responses will require authority higher than the Human Research Program level and some responses may require Congressional action



# An Important Question in Space Medicine and Biology



*What is the Relationship Between Gravity and Biological Activity?*



# ***What is the Relationship Between Gravity and Biological Activity?***

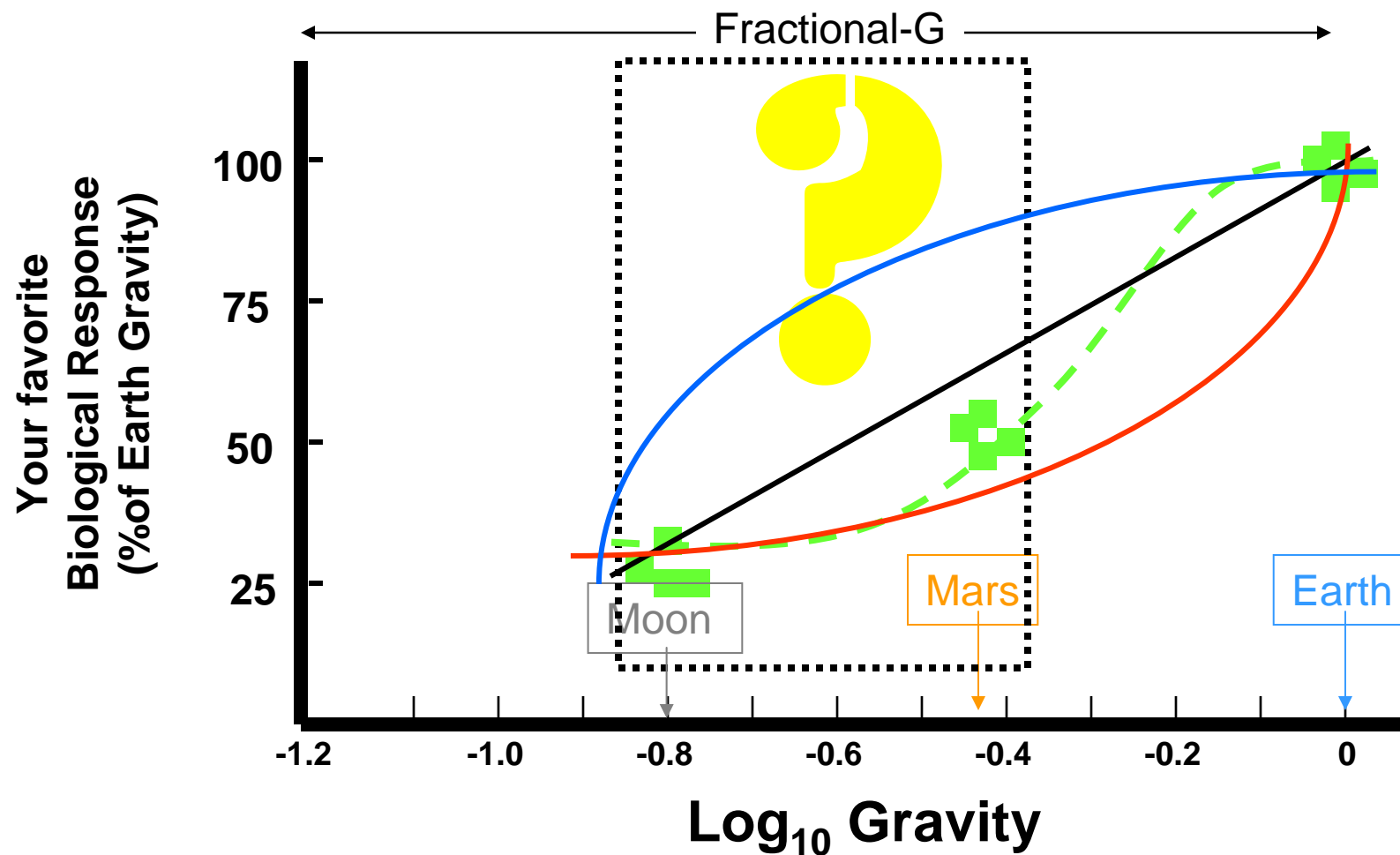


- There is an abundance of data at  $10^{-6}$  to  $10^{-5}$  G (mostly LEO)
- Likewise for  $10^0$  (Earth)
- Essentially no data for the points in between
  - Only gross operational performance data acquired during Apollo lunar surface activities
- What is the threshold G necessary to maintain normal function?
- How often is it necessary to maintain normal function?
- Few dose/response relationships in biology exceed 2 orders of magnitude
- It is possible that the threshold is within one order of magnitude from  $10^0$  G

# Need to do the experiments that elucidate this relationship



## Hypothetical Relationship Between Gravity and Biological Activity



# Conclusions



- Moon and then Mars could provide the opportunities to construct the relationship between gravity and biological response if given appropriate programmatic priority
- Short and long duration stays on the Moon with integrated science will be the next stage in the progress toward exploring deeper into the Solar system
- It has the advantage of proximity and a wealth of previous experience
- Knowledge of the relationships will impact requirements for human health and performance and for mission and vehicle design



# Epilogue

